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A Method Of
Evaluating Forest Site Quality
From Soil, Forest Cover, And Indicator Plants

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FORESTERS HAVE OVERLOOKED too long the importance of soil as a factor in successful timber production. Greatest production in amount and quality of wood at the smallest cost can be attained by growing the tree species that are best suited to the climate and the soil of the locality in question.

In application, however, this principle is all too frequently disregarded. The numerous plantation failures encountered show what happens when it is disregarded. Planting species outside their natural range or on soils to which they are poorly adapted has led to serious silvicultural and pest-control problems. Such mistakes, besides being costly, cast serious doubt on the soundness of reforestation programs.

European experience points up the need for giving more attention to soil-tree relationships. In parts of Germany and Switzerland continuous cropping of spruce on natural hardwood sites has seriously harmed both forest and

soil. Successive rotations of pure spruce deplete the soil of certain elements essential to the health of the stand (5)[1]. The problem there is to bring back sufficient numbers of soil-enriching hardwoods to restore soil and forest to their original productivity.

But we need not go to distant countries for examples of the effects of forest mismanagement. In New England today we have widespread Nectria canker in many northern hardwood stands (6). This may well be due to the fact that these stands occupy soils that were originally occupied by pure softwoods or softwood-hardwood mixtures. Foresters now face the difficult task of reconverting these sites to their original composition.

Another example is the damage done to red pine by the European pine shoot moth and the Tympanis canker when this species is planted south of its natural range (1). Another is the stagnation and chlorosis encountered in pine and spruce plantations on certain worn-out agricultural soils in northern New York -- attributed to potassium deficiency (2). In other regions obscure diseases such as "littleleaf" in shortleaf pine (3, 4) and "pole blight" in second-growth western white pine (7) may be due to a disturbed biotic condition of the soil or to a lack of balance among the essential elements.

Many of these troubles originate in man's failure to grow the species best adapted to the soil. Because basic soil conditions are not given adequate consideration, silvicultural goals are often set that are at variance with the inherent trends of the site. This fact has been attested repeatedly in the well-known effort to maintain white pine as a dominant species in the mixed-hardwood stands of southern New England. On the lighter soils, under skillful silviculture, this highly prized species can be maintained with relative ease. But on the heavier soils that characterize natural hardwood lands the cost of maintaining white pine is prohibitive.

To try to grow species ill adapted to the soil is often an open invitation to inroads by damaging pests. Na-

[1] Numbers in parentheses refer to Literature Cited, page 12.

ture protests vigorously against violation of her laws. Disregarding them can lead only to serious trouble.

Some violations of the principle of fitting the tree to the soil are due to deliberate attempts to gain an economic advantage. But many are due merely to lack of sound silvicultural guides. What the forester needs is a simple yet dependable guide that will enable him to direct his silviculture toward the production of those species that are best suited to the site.

THE CLIMAX FOREST AS A GUIDE

Such a guide can be found in climax-forest associations. A climax forest is Nature's verdict of the tree species or combination of tree species best adapted to the site. Climax forests are in complete harmony with the soil and the plant and animal life they support. They are inherently healthy. Under good management they are easily maintained in a high state of vigor and productivity. They have a natural capacity to resist damage from insects, disease, and other destructive agents.

One should not infer that the composition of the climax forest is the ultimate toward which management should invariably be directed. The high intrinsic value of certain subclimax species such as white pine, Douglas-fir, white birch, and black cherry may dictate otherwise. Nevertheless, compositions characteristic of climax associations should be used as guides for setting up silvicultural and management goals. Such an approach is basically sound.

Often in the past, management practices have been based upon current tree composition alone. But present tree cover may not be a reliable index. Through man's activities extensive forest areas have undergone marked changes in composition and structure; thus their true nature is masked.

A striking example of this was noted in the course of forest survey work in New York State (fig. 1). Raquette Lake Town, which lies wholly within the Adirondack State Park, supports a practically virgin forest of mixed spruce-hardwoods. The adjacent holdings, which are privately owned, were cut for conifers only, leaving the area possessed by northern hardwoods. Although the two ownerships originally

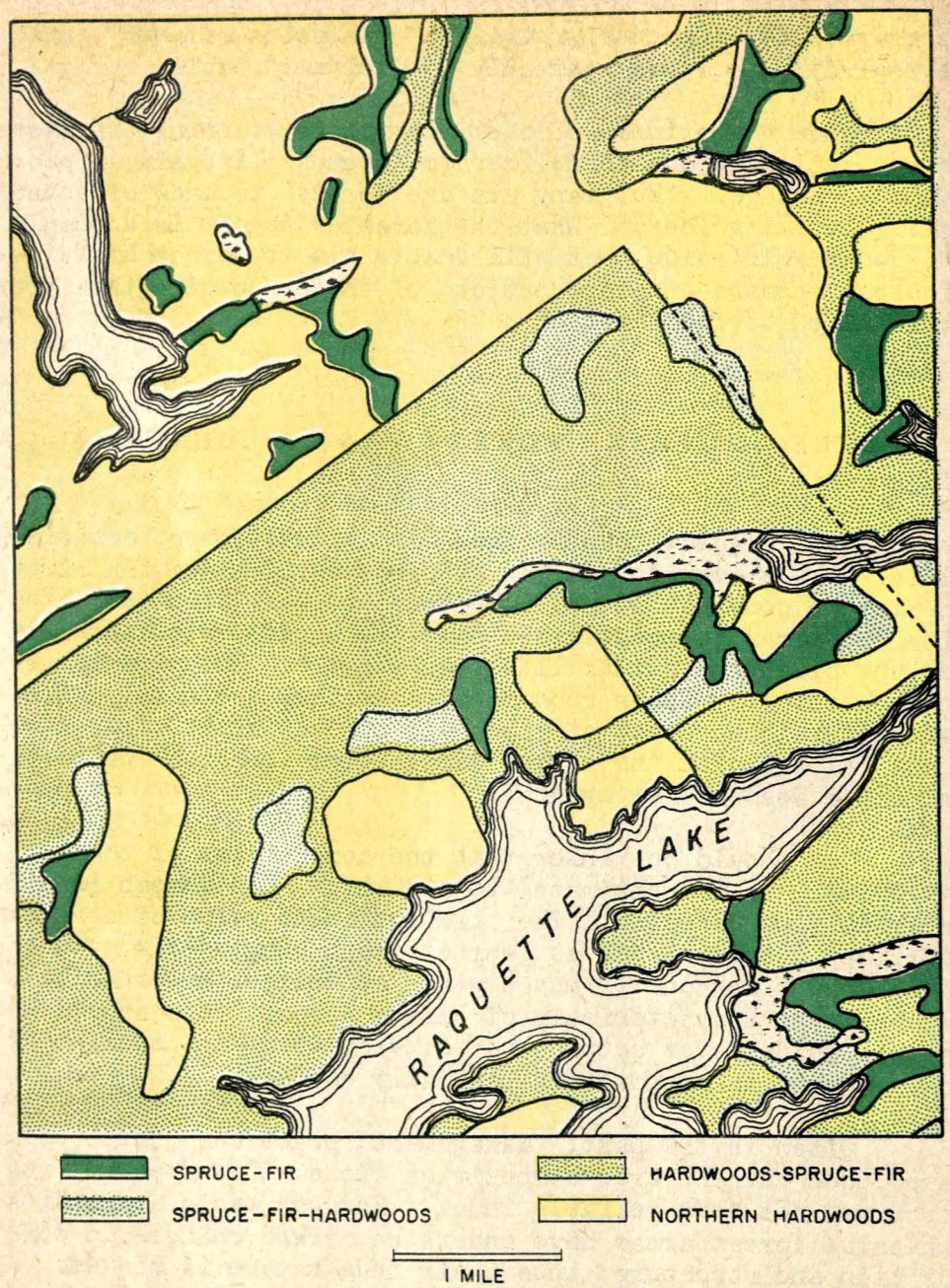


Figure 1.--The sharp, straight boundary between forest cover types shows how man's activities change forest composition. The lower area on this map, part of the Adirondack State Park, is covered by practically virgin forest of mixed spruce and hardwoods. The upper area is private land from which the conifers were cut for pulpwood.

supported forests of the same composition, cutting on the private lands converted a former mixed conifer-hardwood forest into pure hardwoods.

Other striking examples are the scrub oak forests of Pennsylvania and the aspen forests of the Northeast and Lake States. Such modified or temporary types are usually poor indicators of the potentialities of forest sites. So the forester must be able to interpret site factors properly regardless of the present forest cover.

DETERMINING CLIMAX TYPE AND SITE CLASS

Since climax forests provide the key to successful management, the first step in placing the silviculture of a region on a sound basis is to classify the forest land into climax-forest types. Three approaches to this task merit consideration.

1 Interpretation of present forest cover

provides an excellent clue to climax type where the forests still occur in their natural state or have been altered only slightly. Certain tree species are definitely associated with forest types. Some have special significance. For example, the condition and thrift of such species as sugar maple, beech, and white-cedar are indicative of soil type and site quality. But unfortunately much of the Northeast's forest cover is a hodge-podge of temporary types in various stages of succession following disturbances by fire, heavy cutting, and epidemics of insects and diseases. Thus we need to know how to identify climax-forest associations regardless of the cover the site now supports. This leads to the second approach--

2 Use of certain indicator plants

that form a part of the forest-floor vegetation as a guide to soil quality and natural succession (8). Ground-vegetation types are well differentiated and are very constant for the same site type. This characteristic provides a basis whereby site qualities can be identified in terms of natural

forest types. However, indicator plants are not infallible. Radically disturbed areas may defy classification for an indeterminate period. This points to the need for the third, and supplementary approach--

3 Use of soils as indicators

of climax-forest associations. In general, major forest associations will be found to coincide with soils. For example, the climax spruce-fir forests of the north country occur on poorly drained bottomlands reaching back from lakes and streams and also on the shallow and droughty soils of steep mountain slopes. The beech-birch-maple types, on the other hand, clothe the deep, fertile, well-drained soils of the lower mountain slopes and low ridges. Pine forests characterize the droughty coastal sand areas, outwash river valleys, and outwash terraces. In the Piedmont Plateau the shade-enduring oaks, gums, and hickories constitute the climax association. In fact, soil and timber are so closely associated that early settlers used tree composition as guides in choosing land to clear for crops.

Within these broad physiographic regions are soil types that are best suited for the growth of particular tree species or groups of species. Thus, soils should be differentiated on the basis of their relative suitability for the production of specific timber species as well as for their growth potential for these species. Further, they should be classified on the basis of their inherent tendencies for the production of specific climax-forest associations.

TESTING THE THEORY

A field test was made to determine if it is practical to combine present tree cover, minor-vegetation data, and soils data as guides to the climax type. A portion of the Milan quadrangle in northern New Hampshire was chosen for the test because both cover-type and soil maps for it were available. Each map provides the basis for developing separate climax-forest-type maps for the area.

The first climax map, developed by Westveld, was based on his interpretation of present forest-cover type. The second map, based solely on soils data, was prepared

independently by W. H. Lyford, soil scientist, New Hampshire College of Agriculture and Agricultural Experiment Station.

Compared on the ground, the two maps coincided reasonably well. Disagreement amounted to less than 40 percent, and disagreement was consistently between the same two climax types.

Later discussion resolved half the conflict between the two maps, and approximately 80 percent agreement was reached. However, further study is needed to bring to light additional factors that will assure correct identification of questionable areas as well as differentiation of climax associations into site-quality classes.

This first test demonstrates the possible value of the method. Although neither tree cover, minor vetetation, nor soils are by themselves infallible as indicators of climax type, the three used together will, it is believed, provide the basis for relatively accurate determination of climax type.

PRACTICAL APPLICATION

To be useful to the practicing forester, this kind of information about soil and site and climax type should be prepared as a unit map. The steps in preparing such a map are illustrated in figure 2. The four small maps shown in the figure are all of the same area.

Here the pertinent site factors found in studies of the present forest cover, the ground-vegetation indicator plants, and the soil types are integrated into a single map (fig. 2, D) that shows site quality and climax-forest type. Each map portrays, with varying degrees of success, the basic boundaries of the climax associations, which presumably are expressed most accurately in map D. This hypothetical map shows how present tree cover, minor-vegetation data, and soils data can be combined as a silvicultural guide for growing the right tree on the right site. It is a basic forest-management map.

In the hands of a forester such a map is the equivalent of a land-use map. Its value in terms of better forest management can scarcely be overrated. In fact, such a map

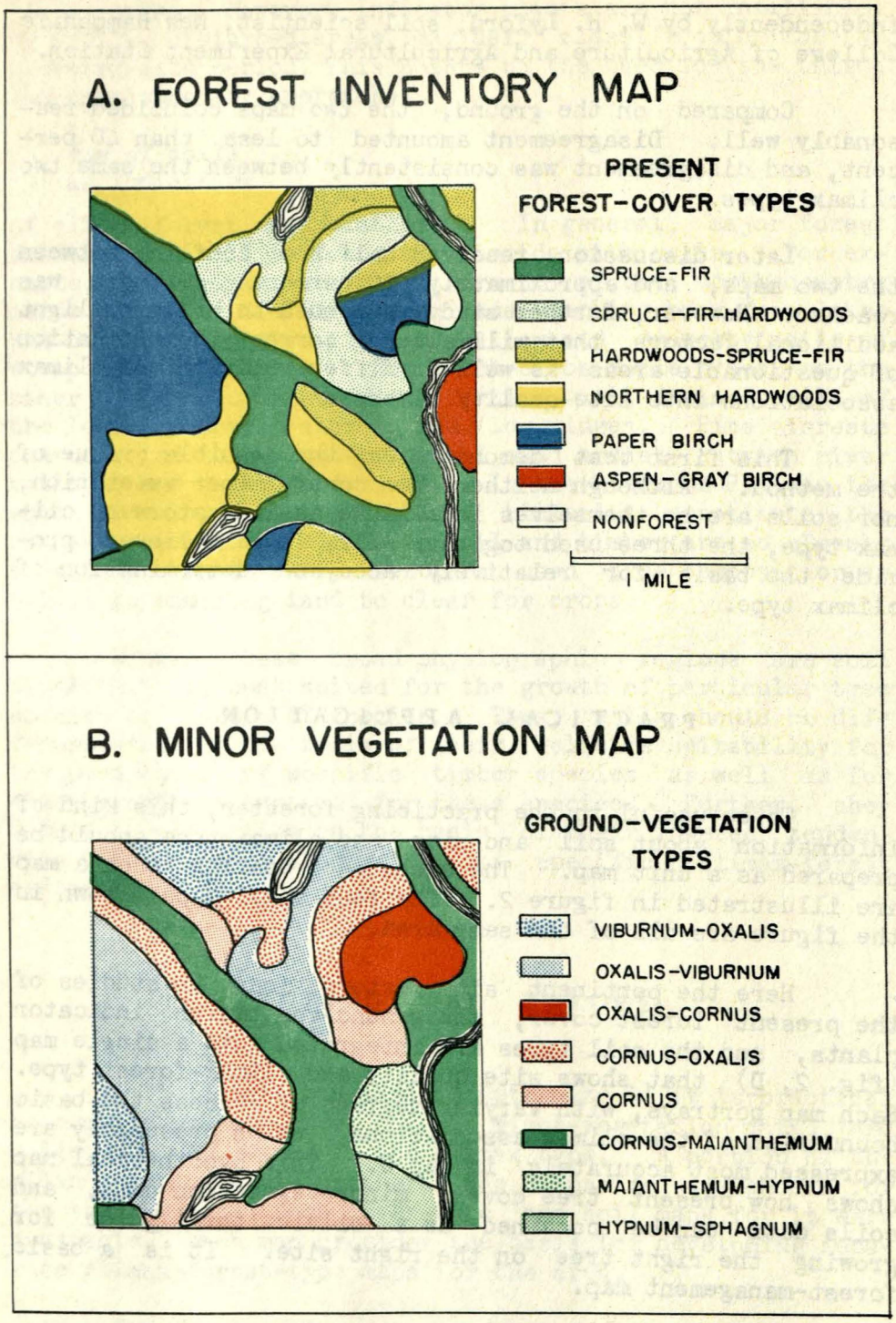
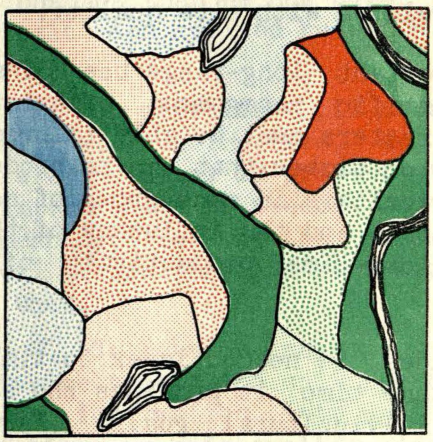
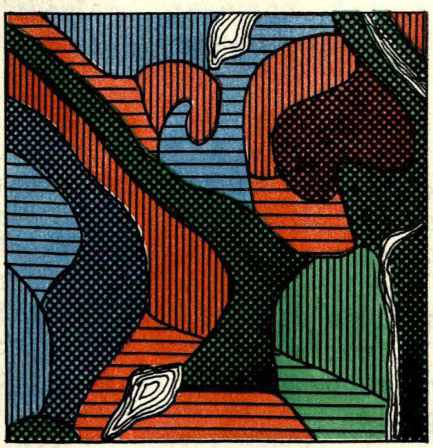


Figure 2.--Steps in mapping soil-site-climax type information. Pertinent site factors shown in *A* (present forest cover), *B* (ground vegetation in-

C. SOIL SURVEY MAP



D. BASIC MANAGEMENT MAP



dicator plants), and *C* (soil types) are integrated into a basic management map, *D*. The four maps are all of the same area.

would have great practical value in all phases of resource management. It could be used effectively in assessing the value of forest types for flood and erosion control, for game production, or for recreation; and in assessing land values. Such a map should also prove valuable in forest-pest prevention and control, since the extent of disease and insect damage is closely correlated with site quality.

Probably the most important long-range use of such maps is as a basis for scientific management of existing forest stands. Ultimately foresters must be able to predict the kind, yield, and quality of timber that can be produced under various systems of silviculture in each group of soils and set of climatic conditions, and the influence of these management systems on the long-time productivity of the soils.

A site-type map provides the needed index to timber-yield potentials. At the same time it provides the basis for proper orientation of silvicultural goals. Knowing where the most favorable site types occur for the growth of specific tree species is one of the principal prerequisites of profitable timber production. Once a property has been thus mapped, the task of classifying sites for various levels of forestry practice commensurate with the potentialities of the site for growth and profitable returns is made infinitely easier.

MORE INFORMATION NEEDED

Fundamentally, then, sound silviculture to a large degree rests on a thorough knowledge of the relationships between the soil and the trees that grow on it. Specifically, skillful soil and forest management consists of (1) selecting the right tree species for a given site or choosing the right site for a given species, (2) maintaining the soil so that it remains suitable for the tree species, and (3) modifying the soil where possible so that it becomes even more suitable for the species.

The method suggested here is, of course, a concept that has not yet been put to practical use. The preparation of basic management maps like that shown in figure 2 has been done only on an experimental basis. Integrating information about present forest cover, indicator-plant communi-

ties, and soil types requires further study, experience, and training.

To fully and effectively use such a method in managing our forests calls for more knowledge about soil-tree relationships than we now have. To obtain this information, both basic and applied research are needed. Some of the problems:

1. To determine soil properties that are significant to the growth of the tree, and to determine what modifications are necessary in present methods of classifying soils. Such information is needed before a soil-type map can have full meaning, because the present classification of soils and soil groups has a strong bias toward strictly agricultural uses.

2. To develop methods for identifying and mapping forest-site types and soil types in the field and translating this information into unit maps showing climax-forest associations by site-quality classes.

3. To evaluate, by pilot-plant operations, the relative economic and silvicultural advantages of (a) various systems and levels of forestry practices for various soil types and (b) the relative advantages of different practices on the same soil type. (Studies of this kind have already been started on several experimental forests.)

4. To interpret the above data in terms usable to the timberland owner and forest manager intent on maintaining and increasing the productivity of his forest land.

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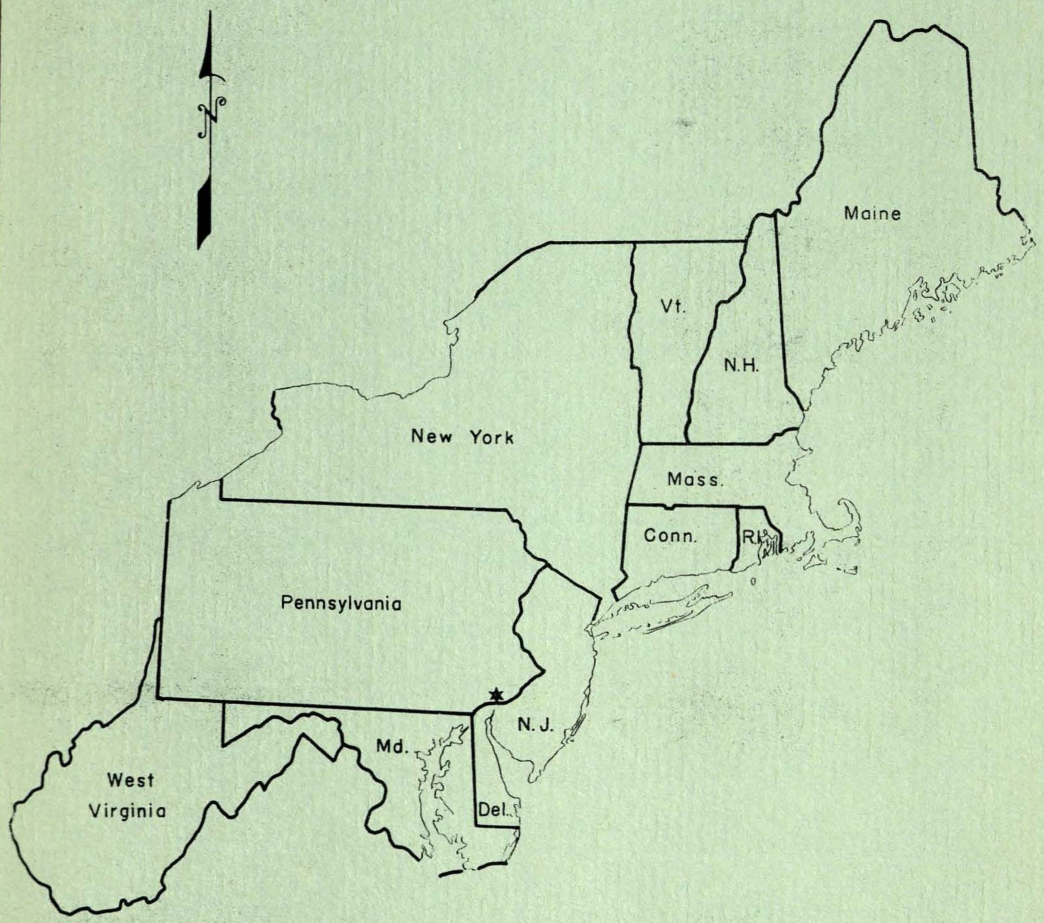

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